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PRODUCTION TECHNOLOGY IN ELECTRICAL MACHINE BUILDING

The technological processes of producing electric machines are more varied than those of general machine building, since besides machining and assembling machines, they include the problems of pressing and assembling cores, producing commutators and brush-holders, winding, soldering, insulating, impregnating and laying coils of the winding, soldering with hand and ~~soft~~ ^{SOFT} solders, etc.

In electrical machine building, specific types of machines are used in addition to metal-cutting machine tools. These include conveyors for varnishing and drying core laminations, conveyors for assembling and finishing machines, powerful eccentric presses for pressing with the use of compound dies, ^{semi-}automatic presses for pressing with slotted dies, machines for casting rotors out of aluminum, winding and insulating machines, balancing machines, and ~~special~~ complex equipment for stretching, pressing, impregnating, drying, and compensating windings.

Industrial accessories, ~~consisting~~ consisting of models of dies, attachments for machining, press molds, and tools are used for carrying out various operations in the production of electric machines.

In electric machine building, dies are especially important and determining to a great degree the cost and quality of the production of machines.

Attachments for machining are often of a very highly-specialized nature.

For example, along with the spacing of holes on plane surfaces, in electric machines, one encounters parts where the holes are spaced according to diameter. Such parts include the frames of DC machines. All types of press molds are used for producing parts ~~out~~ of plastics and insulation materials, including commutators and brush-holders of low power machines and commutator collars made of micaite.

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Special molds are used for parts which are cast under pressure on special machines.

Narrow files and benches for machining ^{rotor} ~~rotor~~ ^{stator} ~~stator~~ and housings of brush-holders are tools which are characteristic of those used in the production of electric machines.

Special tools for laying windings in slots, wrenches for bending rods, knives for cutting slot insulation, and other tools, are used for producing windings.

As far as measuring tools are concerned, one can list the special angular templates for commutator parts, gauges for checking the size of slots, and attachments for checking whether frames and end bearings are coaxial.

Thus, electrical machine building manifests itself as a type of complex production requiring high precision for the production and assembly of individual parts, often amounting to ^{thousandths} ~~thousandths~~ of a millimeter, which ~~processes~~ also includes a ^{great} ~~wide~~ variety of technological processes.

The basic production of electrical machine building is divided into three phases:

1. Initial production
2. Processing
3. Assembly production

Electrical machine production is divided into the following types:

1. Individual or single-unit production
2. Series production
3. Mass production.

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Individual production is used for making large electric machines of single-unit production, such as turbogenerators, hydrogenerators, and other electric machines.

At the majority of Soviet electrical machine building plants, the production of electric machines is carried out in series or small-series. Mass production has been developed only for making small electric motors and generators, in small volumes.

The largest electrical machine building plants of the Soviet Union and the most modern plants have deficient production technology and produce manufacture products at high production ^{costs} ~~costs~~.

The fault lies in the fact that the main leading plants have very broad products lists.

(1) The ~~Electrical Machinery Plant~~ (for example, produces large ~~single-design~~ electric machines, explosion-proof electric motors, direct current machines (from size EM-400 to EM-1750), ⁽¹⁰⁰⁰⁾ ~~hydrogenerators~~, electric motors under 100-hp in power, electric drills, ~~marine AS drive~~ systems, magnetic stations, ~~control~~ ~~apparatus~~, electric pumps and ~~boxes~~, automatic switching, ~~dry-cell operated~~ switchboards, ~~push-buttons~~, etc.

(2) The "Electrofil" Plant produces 12 varieties of ~~hydrogenerators~~, five types of ~~hydrogenerators~~, heavy electric ~~induction and synchronous electric motors~~, ~~synchronous generators~~, a total of ~~push~~ ~~buttons~~.

(1) Vestnik Elektromekhanizatsii, No. 7, 1957
(2) ibid

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(3) The Dinamo Plant, besides producing cranes and ~~general~~ ^{traction} electrical equipment, makes individual general-purpose types of low-voltage apparatus, mobile generating units, and other electrical equipment.

The products list is just as broad at the new plants of the electrical industry, especially at the Ural Elektromashinostroitelnyy Plant and the ~~EMZ~~ ^{Baku} (Baku Electrical Machinery Plant). The data on the ~~structure~~ ^{structure} of the ~~EMZ~~ ^{Baku} plant illustrates excessively ~~the~~ ^{the} breadth of the production structure of new plants:

(4) Electric Motors up to 100 kw	16.9 %
over 100 kw	9.2%
Apparatus	2.9%
Transformers	7.2%
Mobile generating units	43.3%
Generators	0.4%

This adulteration and pile-up of the products lists of the plants of the electrical industry has occurred as a result of the absence of a plan for specialization.

(1) I. T. Skidanchuk, Minister of Electrical Engineering Industry, gives the ~~following~~ ^{following} description of the system of ~~planning~~ ^{and} specialization of plants:

"What is the matter, is that the products lists of a number of plants have been left to, let us say, pile up, during the course of many years in conditions where there was no single plan for specializing plants, and without any kind of serious technical and economic reasons."

(3) Vestnik Elektromashinostroeni, No 1, 1956, p 6

(4) Ibid

(1) Ibid

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The typical organizational structure of the shops of the majority of electrical machine building plants is given here as an illustration.

No	Name of the shop	Basic production functions
1. Hot working shops		
1.	Iron foundry	Casting frames of ^{DC} machines, and bearings, bearing shields, commutators of brush holders, spiders, winding holders.
2.	Steel foundry	Casting DC machine frames, bushings and tapered pins of commutators, and pressure washers of armatures
3.	Non-ferrous metals foundry	Casting of current-carrying parts and and brush-holders out of copper alloys. Casting fans, frames and bearing shields out of light alloys, casting rotors out of aluminum, casting metal patterns.
4.	Forge shop	Hot pressing of support rings, large bolts, forging of blades for axial parts. Bending of rings for pressure washers.
5.	Welding shop	Welding of base plates, frames of large machines, rotors with copper equitrol cages.
6.	Heat-treatment shop	Annealing of commutator core laminations, copper bushings, and bushing coils. Heat-treatment of cutting and measuring tools and attachments.
2. Machine shops		
7.	Shop for machining castings	Machining frames, bearing shields, end-bearings, pressure washers, spiders, and brush-holder commutators.
8.	Shop for machining shafts	Machining shafts and bushings out of rolled steel
9.	Hardware shop	Automatic machining of screws, bolts, and nuts out of aluminum red steel. Cold working of heads of rivets and screws. Machining of small brush-holder parts.
10.	Tool shop	Production of dies, attachments, measuring and cutting tools, and press molds.

(b) Vinogradov, N. V. Технология производства электрических машин

(Technology of producing electric machines), Специализация, 1950, p. 20.

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3. Press shops

1. Shop for cutting and ~~insulating~~ ^{insulating} Cutting plates on shears, removing burrs, and varnishing core laminations.
2. Core plate pressing shop Pressing plates of the armature, stators, rotors, and poles.
3. Small parts pressing shop Pressing parts of the brush-holders, cable terminals, installation boxes, insulated parts.

4. Insulation shops.

4. Shop for micaite plates, bands, and sheets Gluing and pressing micaite, micafoil, mica bands, and composite insulation materials.
5. Parts-pressing shop Pressing commutator collars and laminated insulation, brush-holder bolts, insulating bushings.
6. Plastic shop Pressing parts out of plastics, commutators out of plastics. Pressing plastics onto metal parts
7. Insulation stock shop Cutting of insulation parts out of sheet materials for insulation and winding operations

5. Electrical shops.

8. Wire coils shop Winding and insulating ~~and~~ winding coils out of insulated wire.
9. Busbar coils shop Molding and insulating coils out of bare busbar copper
10. Commutator shop Winding of the mechanical parts of commutators. Assembly of plates into rings. Machining dovetails of commutator plates. Assembly of commutators and contact rings.

6. Winding shops

21. Armature winding shop Insulation of winding frame. Laying of coils in slots. Strip-winding the armature, soldering the winding to the commutator. Final processing of commutator.
22. Rotor winding shop Hand-winding of small rotors. Red winding of rotors. Soldering and strip-winding of windings. Fitting of contact rings.

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23. Stator winding shop

Laying stator winding in slots. Welding and soldering inter-phase joints. Driving of wedges into the slots.

7. Finishing and auxiliary shops

24. Galvanizing shop

Galvanization of parts (tinning, zinc-plating, coating, cadmium-plating). Chrome-plating of press molds and measuring tools for increased wearability.

25. Wire-drawing shop

Drawing copper wires to reduce their diameters. Drawing of special shapes. Gauging red stock for automatic operations.

26. Impregnating shop

Drying, impregnating, and compounding coils and wound armatures, rotors, and stators. Impregnation of insulation materials.

27. Painting and finishing shop Ground coating, filling, and painting parts and finished ~~parts~~ machines.

28. Pattern shop

Production of wooden patterns and core boxes. Production of wooden subpatterns for casting metal patterns.

8. Assembly shops.

29. Core assembly shop

Assembly and pressing of cores of the rotor, stator, armature, and poles on the shaft, in the frame or on special accessories. Fitting commutators on the shaft.

30. Brush-holder and fixtures assembly shop

Assembly of brush holders, Assembly of insulation ~~insulation~~ housing of commutator brushes and ventilation openings, and pressed fans.

31. General assembly shop

Balancing of rotating parts, installation of poles and coils, installation of bearings. Fitting the rotor in the frame. Fitting the bearing shields. Assembly and fitting the crosspiece of the brush-holder and holding fixtures. Installation of the clutch ~~and discs~~.

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Equipment is arranged according to objective indicators. Production lines or bays are organized.

For example, in the machine shops, production lines for milling shafts, end shields, ^(and) frames are being developed. In the winding shops, production lines for armature windings, rotor windings, ^(and) stator windings are being developed.

The mechanization of production processes is in ~~the same~~ as had a state ~~at the new plants~~ as at the old plants. Plants utilize a large percentage of manual labor.

(1) For example, according to ^(industry) official Soviet data:

1. In individual and small-series production (i.e. in old plants) manual labor amounts to from 40 to 50 percent.
2. In series production (i.e. in new plants) manual labor amounts to from 30 to 35 percent.

One can assume that these figures are substantially understated.

(1) The average relation of time of individual operations in series production:

Fitting and assembly stage of work	Percentage of relative time.
Manual bench machining of parts	20 - 25
Subassembly of parts	40 - 45
General assembly	30 - 40
Total	100

(1) B. N. Gan, "Problemy i resheniya razvitiya y. elektromashinostei, ~~... 1956, TK 65 8 3~~

pp 350-351

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Machine shops of electrical machine building plants are classified as small, medium and large shops in accordance with ^{their} rates of production. The number of installed metal-cutting machine tools is set up as a basis for this classification.

(2) Small shop - up to 75 - 150 machine tools

Medium shop - up to 150 - 300 machine tools.

Large shop - ~~up to~~ over 300 machine tools.

(1) The sizes of standard ^{specific} floorspace allotted for machine shops.

Size of machine tools	Specific floor space in square meters
For small machine tools	10 - 20
For medium machine tools	15 - 20
For large machine tools	25 - 30
For very large machine tools	50 - 75

(1) On an average, for general machine building, the floorspace per production worker in an assembly shop amounts to from 15 to 20 square meters.

The specific floorspace for a bench machinist (minus the assembly area) amounts to 5-6 square meters.

For series production in general machine building, the floorspace of the assembly shop on an average amounts to from 30 to 40 percent that of the machine shop. In individual production, it amounts to 60 percent of the machine shop area.

The degree to which tool shops of a plant are well equipped has a great influence on the technological processes of manufacturing electric machines. The majority of the tool shops of plants have poor-quality ~~equipment~~ machine tools, insufficient equipment, and ever-present shortages of necessary tools and materials.

(1) Ibid., pp 350-351.

(2) Ibid., pp 340 & 343).

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Mikhailov, a machinist of the tool shop of the Cheboksary Electrical Plant, a worker with 30 years of experience, describes the operations of the tool shop of his plant in the following manner:

"Despite the utilization of a large number of new dies, presses, jigs, and cutting tools, tool shops do not satisfy all the needs of the plant for tools because of the poor wearability of ^{VAA} ~~low-quality~~ tools. As a result, the plant is forced to produce a large number of duplicate tools. The reason for this is that dies and press molds ~~are~~ are made of steel without following any sort of definite technological process. Other grades of steel are used in place of ~~high-speed~~ 4khN, 5khN, and 6khN steels. Press molds made of such steels wear out from 5 to 6 times as fast. The operations of the plant are also hampered by the absence of standard tools, and the existing tools are not available in sufficient variety."

Directors of plants completely forget about tool shops in their race to fulfill the production plans.

The total number of machine tools in tool shops is usually 13-18 percent the number installed in the main shops served by the tool shops.

~~These figures are not correct and do not reflect the actual situation.~~

(1) Ibid, pp 372, 373.

(2) Vestnik Elektromashinostroyeniya, No 4, 1955, p. 34.

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The percentage ratio of the number of various types of machine tools in a tool shop.

Item	Type of machine tool	Percentage ratio
1.	Cutting-off and centering machines	3
2.	Lathes ⁶	36
3.	Turret lathes	3
4.	Planers	6
5.	Slotters	2
6.	Universal milling machines	6
7.	Vertical milling machines	4
8.	Horizontal milling machines	6
9.	Drilling machines	6
10.	Vertical boring mills and boring machines	2
11.	Cylindrical grinding and thread grinding machines	7
12.	Internal grinding machines	3
13.	Surface grinding machines	3
14.	Tool-grinding and tapping machines	12
15.	Miscellaneous (sawing machines, etc.)	1
	Total	100

The production cycle averages from 12 to 15 working meters per machine tool, including adjustments.

(1) Gan, pp 272-273.

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Electrical machine building is a completely backward branch of industry, both with regard to equipment and processes.

The technical backwardness of electrical machine building is the natural result of the Soviet system itself.

Bureaucratic ossification of the leaders, ^{and} fear of ~~experimentation~~ any kind of experimentation, ~~on the part of the technical~~ and administrative leadership, ^{there} in the Soviet managerial apparatus. New things are implemented with great difficulty, ^{and it takes several years.} Technical backwardness has reached unbelievable proportions in electrical machine building.

Machine tools have been used in the plants for decades of years and are extremely worn and ~~low~~ and low-productive.

Here is what the leading journal of the Ministry of Electrical Engineering Industry says on this subject about one of the leading Soviet electrical machine building plants:

(1) "At the Dima Plant, of the existing 1,510 units of equipment (^{including} overhead traveling cranes, metal vats, and foundry equipment), 309 units have actually been in operation from 15 to 20 years, and 510 units have been in use over 20 years. The large, heavy, and single-design equipment is especially old with regard to actual time of operation. Among 50 units of such equipment, there is a turret lathe produced in 1914, eight machine tools produced before ~~1925~~ 1925, seven before 1930, 17 before 1939, etc."

The situation is the same at the majority of other plants.

As far as plants constructed in the postwar period are concerned, their situation with regard to machine tools is no better.

(1) Vestnik elektromashinostri, No 3, ~~1957~~ 1957, p. 43.

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The reason for this is that most of the postwar plants were constructed on the basis of disassembled equipment from Germany, Austria, Hungary, Japan, etc., which was also technically obsolete and obsolescent.

Operations involving the assembly and finishing of heavy products are the ones that are labor consuming and sparsely mechanized.

For example: (1) At the Moscow Transformer Plant, where large transformers are being assembled, special special machinery is used to finish each transformer (just like during reconstruction in large U.S. plants). Much wood and labor is expended for making these scaffolds, which other countries even Hungary and Austria, who travelling scaffolds for such purposes.

The situation with interplant transport is as follows:

The main types of interplant transport are overhead travelling cranes, electric trolleys, and horizontal transport such as electric cars and hand trucks.

The technological level of production in electrical machine building is far behind the growth of production volume.

The main types of metal-working machine tools in electrical machine building plants are still the following universal types: Vertical boring ^{mill} boring machines, ^{mill} milling machines, single- spindle lathes, drilling machines, planer, turret lathes, and shapers.

(2) The composition of metal-working equipment in the electrical machine building industry is illustrated by the following percentage data:

1. Lathes, turret lathes, boring machines	42
2. Drilling machines and threading machines	25.3
3. Milling machines	11.5
4. Grinding machines	8.1
5. Planers and lapping machines	6.0
6. Unit-type machine tools	0.1
7. Miscellaneous	7.8

(1) Vestnik Elektromashinostroi, No 12, 1956, p 6
(2) Ibid, p 4.

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At these shops, the specific quantity of automatic presses amounts to 10 percent.

Of a percent, and the basic type of presses are the noiseless automatic presses with manual feeds,

There is practically no mechanization in the insulation and winding operations.

The mechanization of winding and insulation operations is limited to several machines for applying turn insulation, pneumatic attachments for stretching wires, and winding machines for producing ^{coils} electric machines, transformers, and apparatus.

The operation of laying winding accounts to 12 to 16 percent of all labor consumption for the production of mass-produced AC machines.

The general level of production technology is illustrated by the following very revealing data:

(1) Unit-type machine tools account for only 0.9 percent of all the equipment installed at the enterprises of the electrical industry.

Vertical multispindle machine tools amount to 0.06 percent.

~~Automatic~~ Multiple-tool automatic lathes amount to 0.25 percent.

At many enterprises of the electrical industry, the proportion of manual labor reaches 60-70 percent. For individual products at certain electrical machine building plants, winding operations amount to 50-60 percent of the total labor consumption for producing electric machines because of their poor state of mechanization.

At the Kondensator Plant, there is no constant flow production in the basic cycles of manufacturing products, and manual labor accounts for 82 percent of the total volume of work done.

At the Tashkent Electrical Engineering Plant, the majority of the parts of multiple switches and protective devices are produced without jigs and fixtures.

(1) Vestnik Elektromekhanizatsii, No 7, 1955, pp. 2-7.

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There is practically no mechanization of foundry operations at the Dinamo Plant, one of the largest enterprises of the ministry. Machine ~~holding~~ ^{welding} accounts for only 10 percent of all welding operations, all the other ~~work~~ ^{welding} is carried out manually.

At the Podol'sk Battery Plant, inter-plate compound, grids, and other parts are cast manually. There is no mechanical feed of grids. There is no mechanization of the loading of paste compounds into hoppers, removal of plates, and sorting of plates. Many more examples in this line could be cited.

(2) Average ~~amount~~ ^{percentage} of labor consumption of ~~these~~ ^{various} technological operations are illustrated by the following data:

Name of the product group	Percentage distribution						
	Machining	Castings	Welding	Press work	Assembly	Welding	Other
Electric motors, AC, up to 1,000 kw	18	24	22	22	7	4	5
DC electric motors up to 200 kw	30	27	20	17	6	10	6
AC generators up to 100 kw	25	24	22	24	6	4	6
Power transformers	12	2	20	24	18	28	4
Low-voltage equipment	21	2	22	20	28	12	8

From the above table, ~~it is evident~~ ^{the various types of work} according to their labor-consumption can be seen clearly. This illustrates the degree to which they are mechanized.

For example: In electrical machine building, the most labor-consuming operations are: the production of castings, welding, ~~mechanical~~ ^{mechanization} operations, machining, press work (with ~~presses~~ ^{presses}); and ~~assembly~~ ^{assembly}.

(1) Vestnik Elektromashinostroyeniya No. 12, June 1958, p. 10.

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In transformer production, welding and initial processing, winding and insulation operations, assembly operations, and machining are most labor consuming.

In apparatus manufacture, machining, press work, ^{and} winding and insulation operations are most labor-consuming.

During the last 1.5-2 years, the Soviet government drew up a number of measures for the purpose of ~~improving~~ raising the technical level, first and foremost, of the most labor-consuming ~~processes~~ processes for each type of product.

Electrical machine building requires full technical equipping. But for this purpose, it is necessary to organize the production of specialized, high-production equipment of a wide variety of types, since the Ministry of Electrical Engineering Industry does not have a suitable material base for the production of special and standard equipment.

Soviet leaders are well aware of the technical backwardness of the electrical industry, and for this reason, they are now taking serious measures toward reequipping existing plants with high-production machinery.

The rate of growth in the volume of production of electrical machines and equipment that has been marked out by the Sixth Five-Year Plan, requires the rapid solution of the problem on organizing a material base for reequipping plants with high-quality high-production equipment. If the necessary reequipping of plants is not carried out, the planned rate of growth of volume of production of electric machines and apparatus will be hard to meet.

The production of the Ministry of Electrical Engineering Industry does not always ~~have~~ have high technical results.

Many types of products are technically obsolete, and technologically ~~are~~ and similar products in non-socialist countries by 10 and more years.

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Soviet technical press organs point out the following:

(1) The basic design principles of current transformers have remained the same as they were 20-30 years.

Of the following:

(2) Electrical machines are being produced according to technical documents developed prior to World War II.

The situation is exactly the same with high-voltage and low-voltage switchgear.

Production technology at plants of the Ministry is so deficient, that even the very same products manufactured at various plants differ greatly in production cost and in other technical characteristics.

(3) At the Khar'kov Electrical Engineering Plant, labor consumption for the production of an A-32-4 electric motor is 30 percent lower than at other plants.

Labor consumption for making the A-32-4 electric motor is from 22-24 percent higher at the Plant named N. I. Baikal, etc. than at the Khar'kov Plant.

At the Baku Electrical Machinery Plant, the labor consumption for making an A-72-4 electric motor is 20-23 percent higher than at the Kurbasselektromotor Plant.

Labor consumption for making the A-31-4 electric motor at the Plant named Vladimir Il'ich is 1.5 times greater than at the Kurbasselektromotor Plant.

(1) Vestnik Elektromashinosteni, No 10, 1956, pp 1-3

(2) Vestnik Elektromashinosteni, No 9, 1956, pp 1-3.

(3) Vestnik Elektromashinosteni, No 12, 1956, pp 1-9.

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The following is an example of the great difference in labor-consumption in the production and laying of windings at different plants:

	Kusbasselektromotor Plant	Plant imeni Vladimir Il'ich
Winding	100 percent	195 percent
Laying of insulation	100 Percent	248 percent
Making of insulation, making connections, and insulation	100 percent	133 percent
Total	100 percent	157 percent

Such a difference in labor consumption at different plants can only be explained by the completely unsatisfactory mechanization and technology of ~~casting operations~~, casting operations, assembly operations, varnishing of motor laminations, painting of machines, and the low level of the equipment of winding and insulation operations. The large amount of scrap produced during the initial processing of produces indicates a poor state of affairs in the technological processes of electrical machine building.

For example, at the Plant imeni Vladimir Il'ich, in 1955, 9,300 tons of magnetic steel were received. Industrial scrap from the 9,300 tons amounted to 6,200 tons, or 67 percent.

About 12 tons of brass are lost at this plant each year for the production of brushes alone.

The products manufactured by the Ministry of Electrical Engineering Industry are not always up to par in quality. The Soviet users of this equipment are always expressing their dissatisfaction with the poor quality of the machines and apparatus.

1) Vestnik Elektromashinostri, No 12, 1956, p 6;

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The problem of the low quality of products was so serious that in 1956, the Ministry carried out special conferences in Moscow, Leningrad, Khar'kov, Zhetysayevsk, and Novosibirsk with the participation of workers of enterprises, scientific research institutes.

The Collegium of the Ministry and the conference noted the following deficiencies (1) in the quality of production:

Traction electric motors of diesel locomotives produced by the Khar'kov Diesel Locomotive Electrical Equipment Plant (KDEE) broke down because the leads of the coils of the supplementary shunt brake off, and the insulators and brush-holder springs were also breaking.

There were cases where the lubricants from the housing of the reducing gear penetrated inside the traction motors etc. Because of imperfections in the design and poor shabby production conditions, a large number of electric motors and main generators were returned to shops after testing.

The Vinnitsa Electrical Engineering Plant produced the M-1 electric spindle that did not conform to technical requirements.

The Vil'nyus Elektrotokhnicheskii and U.P.S. Plants produce electrical products of low quality.

Products of the Elektrolaktyer Plant are of low quality.

Products of the Chelabynskiy Electrical Equipment Plant are of low quality.

The main inspectorate for quality products quality of the Ministry of Electrical Engineering Industry determined that the following plants of Glav'elektroapparat produce extremely low-quality products:

Kondensator, Morskoye, Sverdlovskiy, Khar'kov Electrical Equipment Plant, Kontaktor, Tashkent Electrical Engineering Plant, U.P.S., and others.

The low quality of products indicates the unsatisfactory condition of the technological processes and the technical backlogs of the above-named plants.

(1) Vestnik Elektromashinostroyeniya, No. 12, 1956, p. 40; No. 10, p. 74.

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Low quality carbon brushes for electric machines are still being produced. Plants of the ministry produce low-quality hydrogenerators. Subassemblies for generators often become deformed during operation, since heat-treatment is carried out after the parts are welded in the plant. Subassemblies that are to be joined together are not matched at the plant, and for this reason much extra work is required during their installation.

(2) During the Sixth Five-Year Plan, turbogenerators and hydrogenerators with a total output of 11 million kw are to be produced. More than 7,000 heavy single-design machines and more than 2.5 million electric motors and up to 100 kw in power are to be made. Transformers with outputs amounting to a total of about 42 million kw will also be produced. Other figures include 590 medium electric motors, and 1,700 sets of electrical equipment for diesel engines.

A special plan for carrying out mechanization and automation of electrical industry plants was drawn up by the Ministry of Electrical Engineering Industry in order to make it possible to fulfill the plans for growth in production volume, labor productivity, and the plans for volume and variety of commodity production outlined in the Sixth Five-Year Plan.

Pravda, "Elektrifikatsiya", No 10, 1956, p 80

Pravda, "Elektrifikatsiya", No 12, 1956, p 3

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The plan for automatation and mechanization at the enterprises of the main administration of the Ministry of Electrical Engineering Industry during the Sixth Five-Year Plan is given below:

During the next Five Year Plan, the production of lead-acid batteries will increase by 113 percent, alkali batteries by 139 percent, carbon cells by 203 percent and electric carbon by 224 percent. Output for the main administration as a whole will increase of 2.6 times the level at the beginning of the plan. Labor productivity rose by 142.8 percent for the main administration as a whole, and 125.5 percent for the production of lead-acid batteries and 125.5 percent for the production of alkali batteries.

The following percentage increases in output are forecast during the Sixth Five-Year Plan:

Main administration total	200.2
Lead-acid batteries	180
Alkali batteries	266
Electric carbon	222
Carbon cells	200

The main administration notes that the planned increase in production can be fulfilled only if the following measures are carried out:

1. Speed up the production of lead-acid storage batteries.
2. Organize a constant-flow mechanized line for the production of motor vehicle batteries.
3. Carry out the unification of the plates of motor vehicle, cutter, and other types of batteries.
4. Speed up the process of reinforcing grids of battery plates after they have been cast.

(3) Vestnik Elektromashinostri, No 4, 1956, pp 77-79.

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Develop technology for the continuous preparation of paste compounds, and
for drying coated plates.

Reduce the time for molding plates.

Develop units for the continuous drying of plates, an automatic for molding
plates, and a transport device for collecting and supplying powder from the
grinding mill to the area where plates are coated.

The utilization of double dry separation in all stationary batteries produced.

2. In the production of alkali storage batteries

Improve the specific electrical characteristics of the storage batteries.

Develop technology for short discharge schedules for starting purposes, by using
sectional electrodes or combinations with non-sectional negative electrodes.

Develop technology for precipitating nickelous nickelous oxide hydrate.

Improve the technology of cleaning ores

Accelerate the processes of degreasing and nickel plating.

Develop units for preparing anode compositions, a continuous dryer for drying
plates, and other units for mechanizing and accelerating technological processes.

3. In the production of manganese-zinc cells

Revise the technology of grinding and preparing agglomerate compounds.

Improve the technology of preparing agglomerates without using hoops and
calico

Eliminate the use of corrosive sublimate in formulas for making compounds.

Develop designs and produce experimental models of complex units for grinding

preparing agglomerate compounds and units for assembling zinc zinc cells and
series.

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4. For electroceramic production

1. Improve the technology of utilizing hard binders, with particular attention given to the use of only one kind of pitch with a high ~~melting~~ melting temperature.
2. Improve the technology of annealing non-ferrous metal grids in a hydrogen atmosphere with the automation of this process and improve the technology of the multiple-seat pressing of electrical brushes to size.
3. Develop designs of various automaties for sorting products, and various pneumatic transport devices for carrying friable materials.

From the ~~measures~~ measures for the Sixth Five Year Plan for improving production by the main administration, it is wholly clear that the technology of production in the battery industry is unsatisfactory. The production processes are insufficiently ~~automatized~~ automated and mechanized. Low-production manual labor predominates in production.

The following is the plan for automation and mechanization during the current Five Year Plan for the enterprises of ~~the~~ the Main Administration of the Electric Insulator Industry (I).

1. A number of new constant-flow lines are ~~intended~~ to be organized at plants.
2. Increase in the output of non-standard equipment at the Proletary Plant.
3. Organization of unit-type lines for the preparation of higher compounds at the Proletary, Uralisolator, and Elektroisolator plants.
4. ~~Equipping~~ Equipping neutralizer basins at the Isolator and Proletary plants.
5. Introduction of mechanical feed of fuel into the intermittent furnaces at the Proletary, Uralisolator, ~~Isolator~~ and Elektroisolator plants and at the [Tokarevskiy] Plant ~~in the~~ ~~city~~ ~~of~~ ~~Novosibirsk~~.
6. Acceleration of the construction of the laboratory building of the State Research Electroceramics Institute, and the completion of construction of objects at the Elektroisolator and Uralisolator plants.

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To complete the baking of insulators to tunnel ovens within 2-3 years.

To develop the automatic regulation of thermal processes and of the operations involved in controlling furnaces;

To develop the non-sagger baking of small and medium insulators.

To develop a process of drying and preparatory heating in special tunnel dryers without need for handling the insulators.

Plant for automation and mechanization for the current five year plan at enterprises of (1) The Main Administration of the ^{Building} Electrical Machine/Industry and the Main Administration of Electrical Apparatus Building was as follows:

To modernize 6,700 machine tools and process currently in use at plants

To increase the use of mechanical grippers for ~~unloading~~ feeding individual billets into dies.

To introduce cold pressing on 1,250 high-productive automatic presses.

To build 162 constant-flow conveyor lines for assembling products, ^{and} subassemblies of electric machines, transformers, and apparatus.

To carry out the full mechanization and automation of foundries.

To introduce 145 modern high-^{quality} installations at plants of the Ministry of Electrical Engineering Industry for heating plastic powders for the production of plastic parts.

To install 58 units for painting parts in electrical fields at plants of the ministry

Vestnik Elektromashinostri, No 10, 56, pp 70-71.

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- 9. To introduce the ultrasonic soldering and cleaning machines.
- 10. To increase the number of posts, machines on special tools, multi-spindle machine tools.
- 11. To create the Organization for the Development of Technology and Organizational Structures at the Ministry of Electrical Engineering Industry, which will be an experimental base for the institute, for the purpose of improving the mechanism of production and accelerating the implementation of advanced technology as established in the electrical industry. The Institute would be located in Moscow.
- 12. To install automatic and semi-automatic for wire and nickel plating, washing machines, etc. in the galvanizing shops of large plants.

Along with the mechanization of industrial processes, the Ministry of Electrical Engineering Industry has planned the variety and production of a large number of new machines and apparatus for the current Five-Year Plan.

(1) During the Sixth Five-Year Plan, the electrical industry as a whole has the following assignments:

- 1. The volume of production of electrical products is to be more than doubled.
- 2. Twelve times as much diesel locomotive electrical equipment is to be produced.
- 3. Mainline ^{electric locomotives} production is to be tripled.
- 4. The production of turbogenerators will rise by 2.5 times.
- 5. The production of power transformers will be increased by approximately 2.4 times.
- 6. The production of electrical measuring instruments will be increased by 3.6 times.

(1) Vestnik Elektropromyshlennosti, No 1, '56, pp 1-4; No 11 '56, pp 1-4; No 5 '56, pp 1-4.

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For the electrification of railroad transport:

1. Master the series production of main-line locomotives supplied by AC single-phase industrial frequency current (i.e. 50 cycles)
2. Step up the power of mercury rectifier units up to 4 - 4.5 mva.
3. Expand the production bases for making mercury rectifiers in Jverlovak and Zapozh'ye and construct 3 new specialized plants.
4. Put 8,100 kw of electrified railroad lines into operation
5. Master and produce experimental models of freight locomotives from 2,500 to 3,000 hp.

For high-voltage switchgear.

(1) Mastering of the production electrical equipment for super-high voltages (660 kv AC and 800 kv DC) and increasing the breaking capacity for mastering voltages (for 110 - 150 kv to 1.6 million kva; for 220 kv to 20 million kva, and 300 kv to 20 million kva).

(2) The following is planned for low voltage equipment:

1. Increasing the service life by increasing the number of operations by current to tens of millions per year.
2. Increasing the breaking capacity of circuit breakers, especially automatic switches and protectors by 2.5 times, increasing the breaking capacities of protection devices.
3. Lowering the size and weight of components of circuit breakers, knife switches, and other devices by 1.5 times.
4. Developing standard programs, mechanisms, protection units and control panels.

(6) Vestak Elektromashinostroyeniye, No. 11, 1950, p. 10.

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- (2) "

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5. Develop new, or modernize more than 50 series of low-voltage electrical apparatus, including: automatic switches (universal, selective, high-speed, installation), DC and AC contactors for magnetic starters for heavy duty operations; control and protective relays; magnetic starters for three-phase induction electric motors in place of the series P; remote-type controllers with regulated and non-regulated cams; magnetic amplifiers; Plate type excitation relays, and others.

6. Develop and produce package-type mobile generating units, transformer substations, high-voltage distribution units, control panels, control boards, automatic panels.

7. Develop and produce converters based on semiconductor and magnetoelectric principles.

8. Improve the system of controlling  electric drives. This applies to contactless control systems utilizing magnetic amplifiers in conjunction with semiconductor diodes and transistors, the development of ion electric drive systems, particularly for reversing rolling mills, metal-working machine tools, elevators, hoisting machines, and auxiliary mechanisms of rolling mills.

9. Introduction into production of controlled mercury rectifiers of the sealed type in units with circuit control apparatus, utilizing magnetic amplifiers and semiconductors.

For insulation material, the following is planned:

(1) Expand the use of organosilicon insulation, polyester resins, and glass insulation.

(2) In the cable industry, it is intended to master the production of cable with aluminum sheathing, high-efficiency coaxial cables, high-voltage cables, and new types of enameled wire for electric machines.

(1) (2) Vestnik Elektropromyshlennosti, No 2 1956, p. 25,

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In electrical instrument building, the following is planned:

1. To increase the output of electrical instruments in 1968 at a level 7.2 times that of 1948.
2. To construct several new plants and to modernize existing plants.
3. To expand experimental and test shops.
4. To develop new materials and semi-finished products with accounting given to the needs of electrical instrument building.

By analyzing the problems confronting the Ministry of Electrical Engineering Industry during the Fourth Five-Year Plan, it can be seen that the basic and main trend is the technical and technological reequipping of the entire electrical industry, the modernization of obsolete designs. Particular stress is placed on the design and mass number of single-All-Union series of electric machines and apparatus, series of package type units and automatic devices, individual types of electric drives, etc.

In addition, during the current Five-Year Plan, as distinguished from the past Five-Year Plan, it is proposed that the process of technological reequipping of the electrical industry must go on simultaneously with the modernization of designs and the planning of new types of machines and apparatus. It is proposed that a reserve of new designs of machines be developed in industry. These new designs are to be introduced gradually into production during the next 5-10 years (1)

(1) *Vestnik Elektromashinostri*, No 2 1956, p 3

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... above analysis of the technical and technological status of the Soviet electrical industry shows that the Soviet socialist system has no special technical superiorities, which would aid in the development of the most advanced technology, but conversely, technical progress in the USSR has slowed down and has dropped behind the current level of modern world technology. In order to maintain Soviet technology on the level of modern requirements, it is now in very grave need of obtaining technical information from abroad.

... in the process of "peaceful coexistence," the Soviet government hopes to get the right kind of advantage for the technical reequipping of its industry by utilizing the attainments of foreign technology. The desire to study in the West and the "spying" before the West appears during the past years not only in the Soviet press, but in the speeches of the Soviet leaders.(2)

A characteristic feature of the electrical industry during the new Sixth Five-Year Plan is the general aim to receive 72, 7% percent of the entire growth of industry by increasing labor productivity (i.e., by the further increased exploitation of the USSR working class).

On an average, during the Sixth Five-Year Plan, the volume of production of the electrical industry will be doubled with a minimum of capital outlay for the construction of new enterprises. The number of workers will be increased by only 15 percent. Labor productivity will be increased by 73, 75 percent, as compared to 57,5 percent of the previous five-year plan.

- (2) Pravda, 10 Jun 55
 " 17 Jul 55
 " 18 Oct 55
 Izvestia 7 Oct 55

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During the past five-year plan, the increase in labor productivity accounted for 42 percent of the growth in production; during the Sixth Five-Year Plan, the increase in labor productivity will account for 72.24 percent of the entire growth of production.

The lowering of production costs of equivalent commodities is planned for 20 percent; of this the cutting down of raw materials and other materials will account for 12 percent, and the lowering of shop, plant, and other expenditures per product unit will account for approximately 8 percent (1).

(1) Vestnik Elektromashinosti, No 10, 56, p 78.

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